

Long-Term Variability in the North Pacific in a Physical-Ecosystem Ocean Model

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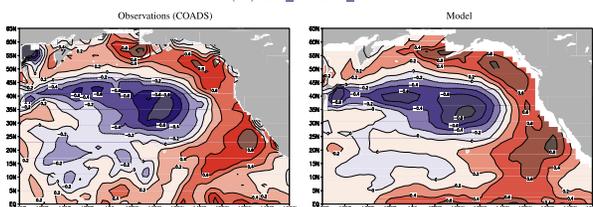
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Introduction

Large-scale changes in the physical environment of the North Pacific Ocean could influence stellar sea lions through several processes, including altering the food web. A basin-wide interdecadal change in both the physical state and the ecology of the North Pacific occurred near the end of 1976 (e.g. Mantua et al. 1997, Bull. Amer. Met. Soc.). Here we use a physical-ecosystem model to examine whether changes in the physical environment, particularly those associated with the 1976-77 transition, influenced the lower trophic levels of the food web.

SST (°C) 1977_98 - 1960_76 FMA



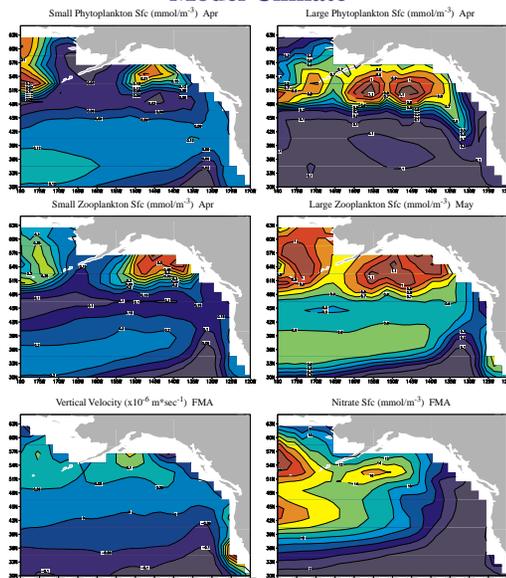
Physical-Biological Model (Chai et al. 2003, J. Oceanogr.)

• **Physical Component:** NCAR Ocean General Circulation Model (Gent et al. 1998, J. Climate; Li et al. 2001, J. Climate). Simulates temperature, currents, upwelling and mixing.

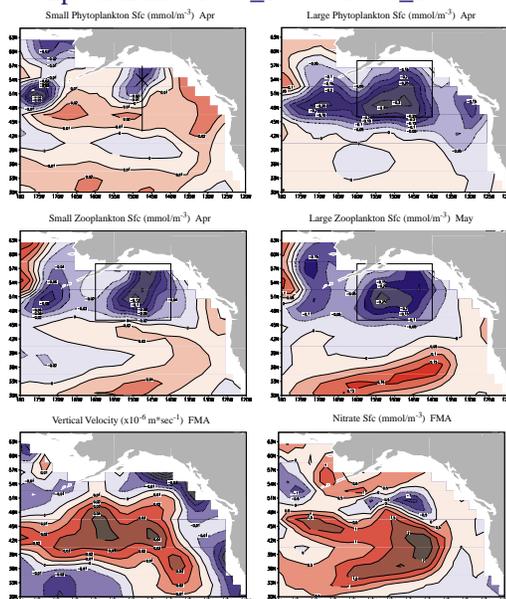
• **Biological Component:** 10 compartments - 2 phytoplankton, 2 zooplankton, 3 forms of nitrogen, 2 forms of silicate and CO₂ (Chai et al. 2002, Deep Sea Rea.).

- **Domain:** 45°S to 65°N in the Pacific Ocean
- **Resolution:** 2° longitude by 2° latitude (north of 20°N) 40 vertical levels.
- **Forcing:** observed atmospheric fields over the period 1960-1999.

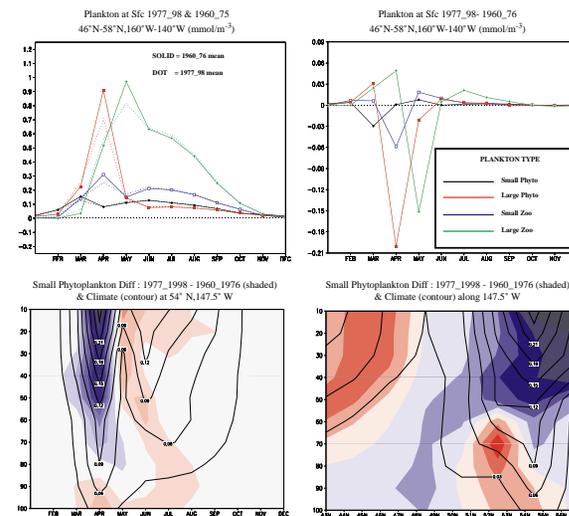
Model Climate



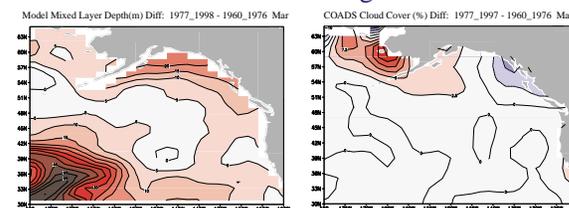
Epoch Diffs: 1977_1998 - 1960_1976



EPOC Difference: NE Pacific 1977_98 - 1960_76



Possible Mechanism: Light Limitation



Discussion

The model indicates that there is ~20% reduction in the spring plankton bloom in the Gulf of Alaska in 1977-98 relative to 1960-76. The reduction in Ekman pumping in the latter period caused the halocline to deepen, leading to deeper mixed layers along the south coast of Alaska. This along with less sunlight (more clouds) could limit the light available for photosynthesis in the northern Gulf. The decrease in plankton during spring, especially the larger phyto and zooplankton, could influence higher trophic levels and negatively impact stellar sea lions at a critical time of year. However, the model results have to be reconciled with some observational studies that have suggested an increase in plankton and Psh populations in the northeast Pacific after 1976. We note that the inadequate treatment of iron as a limiting nutrient in the model likely results in an overestimate of the mean phytoplankton concentration and could effect long-term plankton variability as well.